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Reproductive Outcomes among Gulf War Era US Military Veterans:

Miscarriages May be Increased

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ABSTRACT (247 words)

Context Veterans of the 1991 Gulf War may have had exposures adversely affecting their reproductive health. We examined the reproductive health of male Gulf War veterans and their spouses in a nationally representative sample of 1991-era US military personnel.

Objective Compare the reproductive health in a nationally representative sample of 1991-era male US military veterans and their spouses, Gulf War deployed and nondeployed.

Design Self-completed postal survey of 1991-95 outcomes in a probability-based sample of male 1991-era veterans.

Setting Male US military veterans, married and aged 18-33 years in 1991, and their spouses.

Study Participants A total of 8915 Gulf War deployed and nondeployed subjects were selected after stratifying for branch of service and component.

Main Outcome Measures Self-reported reproductive outcomes.

Results In total, 2716 Gulf War and 2169 nondeployed veterans responded, a participation rate of 62.0%, adjusting for 1032 undeliverable questionnaires. Nondeployed veterans were underrepresented in the respondents ($p<0.001$). No significant differences were found in the odds of reporting births, ectopic pregnancies, or stillbirths. Male Gulf War veterans reported an increased odds of their spouses experiencing a miscarriage in 1991-92 (adjusted odds ratio=1.72; 95 percent confidence interval 1.14, 2.59). This effect did not persist into 1993-95.

Conclusions Spouses of male Gulf War veterans experienced increased odds of miscarriages in 1991-92. Given the possibility of response bias due to underrepresentation of nondeployed veterans, among other reasons, additional studies will be needed to confirm the nonpersistent postwar increase in miscarriages among couples with male Gulf War veterans.

A number of veterans of the 1991 Gulf War have complained of diverse symptoms and illnesses, possibly related to their military service during that conflict. Concern has been voiced that some of these veterans may have had exposures that adversely affected their reproductive health [1]. A US General Accounting Office report [2] identified the need to examine these concerns in nationally representative samples of US military service members including all services (Army, Navy, Air Force, Marine Corps) and components (active duty, reserve, and National Guard). We report here on male US military veterans from the Gulf War era, as a companion article to our report on the reproductive outcomes among female US military veterans (Sato et al, Naval Health Research Center, unpublished manuscript). Our objective was to examine the reproductive health of Gulf War-era male US military veterans, deployed and nondeployed, and their spouses in a nationally representative sample with proportionate representation of all services and components.

METHODS

Study population

Male US military veterans who were in the Gulf War theater of operations between August 1, 1990, and July 31, 1991, aged 18-33 years and married on February 1, 1991 were considered Gulf War veterans. Married male veterans aged 18-33 years of the same era but not deployed to the Gulf War theater of operations were defined as nondeployed veterans. All service and components were represented in the study population. Deployment status was determined by DMDC from hostile fire pay records, and military unit deployment data.

This study was conducted in accordance with the Protection of Human Subjects guidelines from the US Department of the Navy. The study protocol and informed consent

issues were reviewed for this purpose by our institutional review board, and approval for the study obtained.

Sample size

The minimum sample size requirement was estimated at 8000 based on detecting a 10 percent difference in rates of miscarriages between Gulf War veterans and nondeployed veterans. However, because we were dealing with a highly mobile and young population several years after the Gulf War, we selected a total of 10 000 individuals through a probability-based selection process, to make allowances for losses. Acceptable limits of β-error were defined as 0.20, and α-error at 0.05.

Of the approximately 2 500 000 male active-duty, reserve, and National Guard service members in 1991, approximately 644 000 were deployed to the Gulf War theater of operations. From this population, a stratified random sample of 5000 with proportionate allocation of service and their components was generated for each of the Gulf War veterans and nondeployed veterans groups, for the total sample of 10 000.

Questionnaire

A four-page, self-completed postal questionnaire composed of both multiple-choice and open-ended questions was developed and field-tested. To enhance the validity and generalizability of the results, previously standardized questions were used in the questionnaire wherever possible. Sources of the questions included the Chicago Reproductive Health Survey (National Institute of Environmental Health Sciences, Research Triangle Park, NC, 1991), the National Survey on Family Growth, Cycle IV (National Center for Health Statistics, Hyattsville, MD, 1988), and the National Maternal and Infant Survey (National Center for Health Statistics, Hyattsville, MD, 1988). The questionnaire obtained demographic data (race/ethnicity and

educational attainment), as well as information on military component, deployment, and information on the main outcomes measures: reproductive outcomes (livebirths, ectopic pregnancies, miscarriages/spontaneous abortions, and stillbirths).

Reproductive outcomes

For each reproductive outcome, respondents were encouraged to consult with their spouses and specify the date of the outcome, and whether the pregnancy had resulted in ectopic pregnancy (fetal death after extra uterine implantation), miscarriage (fetal death before 22 weeks of gestation), stillbirth (fetal death at or after 22 weeks of gestation), or livebirth (child born alive).

Information on birth weight, gestational age, and the sex of the infant was sought for each live birth. Subjects were asked to complete separate entries for each outcome in a multiple-birth pregnancy.

Pilot study

The survey questionnaires were pilot-tested among 14 individuals from outside the study population. Information from the pilot study was used to finalize the survey instrument.

Data collection

Survey Mailing Process. The 10 000 initially selected were mailed a preliminary notification letter. These letters, mailed in February 1996, introduced the study to prospective participants and attempted to answer all anticipated questions about the study's purpose and objectives. It also sought to address any concerns about confidentiality of information that would be collected.

Study questionnaires were mailed to the 8915 subjects whose preliminary letters were not returned as undeliverable. Three rounds of questionnaires were mailed out over the next 18 months. Each mailing targeted those individuals who had not responded within 6 months to the

preceding mailing. Specific study letterheads and logos were used for all correspondence with study subjects during the mailings to make our mailings easily distinguishable from other mail. To encourage responses, reminder postcards were sent 3 weeks after each mailing.

For subjects remaining on active duty, we routed surveys through their commanding officers. For the attention of these commanders, we attached letters from each service's Surgeon General, stressing the importance of this study and requesting that the commanding officers encourage potential study subjects to participate.

For subjects no longer on active duty, cover letters that incorporated comments describing other respondents' feelings about the significance and value of the study were included with the questionnaires, again to encourage participation.

Tracing correct addresses. Addresses obtained from the DMDC were used for initial mailings. If questionnaires were returned as undeliverable, additional sources were accessed to identify the most likely current valid addresses: the locator services of each branch of the military, Internal Revenue Service address data, and a commercial locator agency.

Collecting Missing Information. After completion of the third and final mailing, 1042 subjects were re-contacted by telephone to obtain missing information on incomplete questionnaires or to clarify responses. Five attempts to establish telephone contact were made to each apparently accurate phone number either obtained from the survey or acquired through an outside locator service. Attempts to contact by phone were made both during the week (2-3 times in the evening), as well as during weekends between 9 a.m. and 5 p.m. in the call recipients' time zone, before a subject survey was classified as "unreachable."

Supplemental information was obtained for 65.9% (687/1042) with missing information. Information could not be obtained from the remaining 355 individuals. Of these, 107 had

refused to provide further information over the telephone, or they could not be interviewed despite repeated attempts at contact through an apparently correct telephone number. Correct telephone numbers could not be identified for the other 248, despite multiple attempts.

Validation

To validate the answers provided by self-reported questionnaire, electronic hospital discharge records from US Department of Defense hospitals were compared with survey responses. Only subjects who remained on active duty during 1991-1995 were examined, since only data on hospitalizations among service members on active duty were available. Responses were considered validated if the same or similar diagnosis was noted in the records within the same calendar year. No electronic data were available for hospitalizations outside Department of Defense facilities, or for ambulatory visits for the time period of interest, 1991-1995.

Statistical Analysis

Frequencies of demographic data were generated for univariate analysis. Age was determined as of February 1, 1991. A multivariate logistic regression model was developed to generate odds ratios (OR), adjusted by age, race/ethnicity, highest level of education attained, military component, and pre-1991 reproductive outcomes. All reproductive outcomes occurring up to December 31, 1995, in the sample populations were included in the analysis. Post–Gulf War reproductive outcomes were defined as those occurring after May 31, 1991; outcomes at or before that date were defined as "pre-1991 outcomes". Univariate analysis was carried out for outcomes such as multiple births, ectopic pregnancies, and stillbirths, where sample size limitations excluded the use of multivariate models. Singleton and multiple births were analyzed separately.

RESULTS

The sample included 8915 selected subjects. Overall, 4885 (54.8 percent) of subjects returned a questionnaire; of these, 563 were returned blank. Excluding 1032 questionnaires that could not be delivered despite several attempts at tracing, the participation rate was 62.0 percent (4885/7883). Responses for singleton and multiple births were analyzed separately. Subjects who were nondeployed, reservists, Army veterans, and black were less likely to have participated in the study (Table 1).

Total births

A total of 5158 singleton livebirths, and 66 twin/higher-order multiple births were reported by Gulf War veterans and nondeployed veterans. Of these, 2376 singleton births and 21 twin births occurred after the Gulf War. The proportional distribution of these births was similar to that reported by the National Center for Health Statistics for all births in the US in 1995 (Figure 1). The odds of birth in couples with male Gulf War veterans in the four years following the conflict did not differ significantly from that among nondeployed veterans, after adjustment for the effects of influential covariates (adjusted odds ratio (OR)= 0.81, 95 percent confidence interval (CI) 0.57, 1.15) (Table 2).

Macrosomia (birth weight ≥4000 g)

Singleton macrosomic infants represented 13.4 percent (318/2376) of all births occurring after the Gulf War. A total of 655 macrosomic births were reported by subjects. No statistical association was found between Gulf War deployment and delivery of macrosomic babies post-Gulf War (adjusted OR= 0.89, 95% CI 0.69, 1.17). Previous macrosomic births was associated with an increased odds of such a birth post-Gulf War (adjusted OR= 3.94, 95 percent CI 2.35, 6.60) (Table 2).

Normal weight singleton births

Singleton babies born with normal birth weights (2500-3999 g) accounted for 81.1 percent (1926/2376) of all singleton births reported following the Gulf War. There were a total of 4202 normal weight singleton births reported by subjects. The odds of having a normal birth weight infant were no different among Gulf War veterans when compared with nondeployed veterans (adjusted OR= 1.06, 95 percent CI 0.86, 1.31). Previous normal weight singleton births was highly associated with the odds of a similar birth post-Gulf War (adjusted OR= 4.65, 95 percent CI 3.19, 6.79) (Table 2).

Low birth weight (LBW) singleton births

Respondents reported 119 births with birth weights of 1500-2500 g, or 5.01 percent (119/2376) of all reported singleton births post-Gulf War. An additional 13 (0.55 percent of births post-Gulf War) were born with birth weights of <1500 g. Overall, a total of 301 LBW (<2500 g) births were reported by subjects. Given the small number of very low birth weight (<1500 g) births reported, all LBW births (<2500 g) were analyzed together. No statistically significant association between Gulf War deployment, and fathering LBW infants post-Gulf War was identified (adjusted OR= 1.38, 95 percent CI 0.91, 2.09). Previous LBW births were associated with significant odds of a similar birth post-Gulf War (adjusted OR= 8.01, 95 percent CI 3.35, 19.12) (Table 2).

Twin and other multiple births

Respondents reported a total of 21 twin births after the Gulf War, out of a total of 66 twin births. There were no triplet or higher order births. The multiple birth ratio was 8.8/1000 livebirths. No statistical association between Gulf War deployment and twin/multiple births was detected (age adjusted OR= 0.86, 95 percent C.I. 0.47, 1.56) (data not shown).

Total reproductive losses

In the period following the Gulf War, a total of 385 reproductive losses, consisting of 25 stillbirths, 50 ectopic pregnancies, and 310 miscarriages were reported. Overall, a total of 801 reproductive losses were reported. The odds of reproductive losses overall was no different between Gulf War veterans and nondeployed veterans post-Gulf War (adjusted OR= 1.25, 95 percent CI 0.98, 1.59) (Table 3).

Stillbirths

Forty-four stillbirths were reported by subjects, of which 25 occurred post-Gulf War. No statistically significant differences in the odds for stillbirths between Gulf War veterans and nondeployed veterans was identified (adjusted OR= 1.32, 95 percent CI 0.52, 3.34) (Table 3).

Ectopic pregnancies

None of the 82 ectopic pregnancies reported overall resulted in a livebirth. Fifty ectopic pregnancies were reported in the period following the Gulf War. No statistical association between ectopic pregnancy and Gulf War deployment status was found (adjusted OR= 0.92, 95 percent CI 0.49, 1.72) (Table 3).

Miscarriages/spontaneous abortions

A total of 675 miscarriages were reported, of which 310 were post-Gulf War. After adjustment for the contributing effects of age, race/ethnicity, educational status, and military component, male Gulf War veterans were at increased odds of fathering a miscarriage postwar (adjusted OR= 1.32, 95 percent CI 1.02, 1.73). When the post-Gulf War years were analyzed in more detail, the increased odds of miscarriage were in the first 2 years following the conflict (adjusted OR= 1.72, 95 percent CI 1.14, 2.59) (Table 4).

Validation of self-reported outcomes

Table 5 presents the percentage of reported reproductive outcomes in which medical records validated questionnaire responses. Validation of reported miscarriages was low.

COMMENT AND CONCLUSIONS

Several previous studies have examined the possibility of adverse reproductive outcomes among 1991 Gulf War veterans. Penman et al. [3] found no association of Gulf War deployment with ill health or birth defects in 2 units of the Mississippi National Guard. Internal Air Force [4] and Army [5, 6] investigations of pregnancy outcomes and miscarriages in Gulf War veterans also found no consistent pattern.

Other studies identified potential sources of concern. A postal survey of present and former Pennsylvania and Hawaii active-duty, Reserve, and National Guard service members [7], found that deployed reservists had a greater likelihood of reporting "menstrual difficulties" than nondeployed reservists. A study among Iowa military veterans found a higher prevalence of complaints of sexual discomfort among Gulf War veterans and their female partners [8].

With regard to birth defects, to date no increased general or specific risk related to Gulf War deployment has been definitively identified to date [9, 10]

Our finding of an increased odds for male Gulf War veterans reporting that their spouses had a miscarriage in the first 2 years following the Gulf War, lends some support to the hypothesis of an increase in adverse reproductive outcomes in Gulf War veterans. However, in our view this finding should be interpreted in the context of the following: (a) the absence of a similar finding among female Gulf War veterans (Sato et al, Naval Health Research Center, unpublished manuscript), despite having studied male and female veterans using similar methods; (b) the possibility of response bias, given the underrepresentation of nondeployed

veterans in the responders when compared with the sample population; (c) the possibility of recall bias between Gulf War veterans and nondeployed veterans, given the low rates of validation of miscarriages; (d) the well-known difficulty in establishing population rates for miscarriages, given the frequency of occult losses, and miscarriages occurring outside of the health care system [11]; and finally (e) the absence of any major differences in birth outcomes between Gulf War veterans and nondeployed veterans in either male or female veterans pointing in the same direction of decreased fetal viability.

The increase risk of miscarriages post-Gulf War is consistent with the reported Vietnam War experience [12], and with reports of increased rates in Bahrain and Kuwait postwar [13, 14]. Known causes of miscarriages are many, but they include chromosomal abnormalities, structural anomalies of the female reproductive system, smoking, caffeine, alcohol or medication use during pregnancy by the mother, as well as sexually transmitted diseases, pesticides, manual labor, work fatigue, and stressful life events [11, 15].

These risk factors have generally been established with respect to miscarriages after exposure of women. Male-mediated risk factors resulting in miscarriages remain not fully understood [11], but exposure to thiocarbamate fungicide/herbicides and carbaryl pesticides in agricultural settings [16], mercury, and anesthetic gases [17], and possibly other agents, such as hydrocarbons, chlorinated pesticides and organophosphates [17, 18], have been implicated. In the Gulf War setting, we speculate that the most plausible exposures potentially causally linked to any increase in miscarriages are not only among the pesticides and hydrocarbons, but also personal and familial stress [15] postwar and after prolonged separation, as well as other factors, including maternal factors. This hypothesis would not account for why female service members

who served in the Gulf and studied by us did not experience increased odds of miscarriages postwar (Sato et al, Naval Health Research Center, unpublished manuscript).

Another accompanying article (Araneta et al, Naval Health Research Center, unpublished manuscript), reports on a related study looking at pregnancy outcomes among female Gulf War veterans on active duty, who had pregnancy-related military hospitalizations on dates suggestive of a Gulf War exposed conception. Araneta and her coworkers also noted increased odds of miscarriage among postwar conceptions reported by subjects. Their study subjects reported increased odds of ectopic pregnancies among postwar conceptions. Important methodological differences are likely to have influenced the differences in results. Subjects of the Araneta study were all female, whereas our results concern male veterans and their spouses alone. Over one-third of the subjects in the Araneta study were unmarried. Their subject selection criteria did not include age limits. We also note that study participation rates differed between the two studies, and that military hospitalizations are thought to account for less than 60% of births to active duty military families in 1998 (William Honner, DoD Birth Defects Registry, Naval Health Research Center, Personal Communication, 1999).

Several limitations were also inherent to the design of our study. The self-reported nature of the questionnaire suggests that the study results should be interpreted cautiously. We adopted a postal survey format to ensure the collection of a demographically representative sample of the services and their components. Because of this format, data on exposures and specific reproductive risk factors were not collected. The addition of questions on exposure and risk factors would have increased considerably the length of the questionnaire, given the large number of putative exposures discussed in relation to the Gulf War in 1994-1995. Further, for

many of the exposures, serious questions could have been raised as to the viability of collecting valid data using a mailed, self-completed method [19].

Although participation was relatively high in comparison to other postal surveys in military service members [7, 20] at 62.0 percent, it is possible that nonresponse could have biased our results. It is of particular concern that a disproportionate number of Gulf War veterans responded. Multivariable analysis would have helped account for much of these differences, but the possibility that our results were due to a response bias, where (in our case) the respondents differed in their miscarriage reproductive history from those who did not respond, has not been excluded.

In conclusion, while no persistent disease process affecting the reproductive health of Gulf War veterans is suggested by our results, further studies will be needed to confirm the apparent nonpersistent increase in miscarriages in the immediate post-Gulf War period among the wives of male Gulf War veterans, as well as identifying the factors underlying any such events.

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FIGURE 1. Birth outcomes reported by male service members, 1991-1995, by birth weight.

Footnote: * National vital statistics on births, 1995, from the National Center for Health Statistics (NCHS), presented for comparison purposes.

TABLE 1. Demographic data

	Sample		
	Population	Responders	*p* value
	N = 8,915	N = 4,322	
	%	%	
Deployment status			<0.001
Nondeployed	50.14	42.23	
Gulf War deployed	49.86	57.77	
Age group, in years			<0.001
≤19	4.60	4.19	
20-24	35.78	31.94	
25-29	36.53	38.27	
≥30	23.85	25.60	
Race/ethnicity			<0.001
White	71.45	76.54	
Black	19.74	15.41	
Hispanic	5.06	4.56	
Other	3.75	3.49	
Highest educational level			<0.001
High school or less	81.75	79.63	
College	9.32	11.96	

Postgraduate	1.11	1.36	
No information	7.82	7.06	
Service			<0.001
Army	37.54	31.78	
Navy	25.81	29.39	
Air Force	24.49	27.56	
Marine Corps	12.16	11.27	
Service Component			<0.01
Active duty	92.73	96.70	
Reserve	4.53	2.00	
National Guard	2.74	1.30	

TABLE 1. Demographic data (cont)

TABLE 2. Singleton birth outcomes, by Gulf War deployment status, military, and demographic covariates

	Macrosomic births (≥4000g) N=318		Normal weight births (2500-3999g) N=1,926		LBW* Births (<2500g) N=132		All births N=2,376	
	AOR†	95% CI‡	AOR	95% CI	AOR	95% CI	AOR	95% CI
Deployment status								
Nondeployed §								
Gulf War deployed	0.89	0.69, 1.17	1.06	0.86, 1.31	1.38	0.91, 2.09	0.81	0.57, 1.15
Age group, in years								
≤19 §								
20-24	1.06	0.55, 2.03	0.83	0.51, 1.36	1.31	0.50, 3.44	1.02	0.47, 2.23
25-29	1.26	0.65, 2.44	0.83	0.50, 1.36	1.27	0.48, 3.39	0.96	0.43, 2.12
≥30	1.24	0.61, 2.53	0.70	0.41, 1.21	1.15	0.39, 3.39	0.61	0.26-1.43
Race/ethnicity								
White §								
Black	0.49	0.31, 0.78	0.88	0.66, 1.19	2.05	1.27, 3.33	0.86	0.53, 1.37
Hispanic	0.49	0.25, 0.95	0.93	0.61, 1.41	1.11	0.49, 2.48	0.56	0.32, 0.99
Other	0.48	0.23, 1.02	0.69	0.44, 1.09	1.25	0.52, 3.01	0.59	0.30, 1.15
Highest educational level								

High school or less §								
College	1.04	0.76, 1.44	1.10	0.86, 1.39	0.96	0.61, 1.51	1.08	0.74, 1.59
Postgraduate	1.39	0.81, 2.36	1.53	0.95, 2.47	1.30	0.56, 2.99	3.51	1.20, 10.26
Service component								
Active duty §								
Reserve	0.41	0.10, 1.72	1.48	0.61, 3.59	¶	¶	0.93	0.28, 3.11
National Guard	0.36	0.05, 2.69	1.13	0.40, 3.26	¶	¶	0.25	0.09, 0.72
Pre-1991 outcomes								
None	0.99	0.45, 1.19	3.46	0.34, 5.10	2.04	0.90, 4.63	1.15	0.61, 2.18
Macrosomic births	3.94	2.35, 6.60	1.06	0.65, 1.72	1.25	0.45, 3.48	5.39	1.25, 23.25
Normal weight births	0.73	0.45, 1.19	4.65	3.19, 6.79	1.17	0.55, 2.53	1.56	0.84, 2.89
LBW births	0.26	0.06, 6.60	1.46	0.74, 2.85	8.01	3.35, 19.12	0.70	0.27, 1.83
Stillbirths/ectopics	0.96	0.21, 4.47	1.05	0.36 ,3.03	2.02	0.41, 10.04	0.30	0.09, 1.00
Miscarriages	1.15	0.68, 1.93	1.06	0.69, 1.63	1.43	0.62, 3.25	0.60	0.31, 1.13

* LBW: Low birth weight; † AOR: Adjusted odds ratio; ‡ CI: Confidence interval; § Reference category; ¶ Insufficient data

TABLE 2. Singleton birth outcomes, by Gulf War deployment status, military, and demographic covariates (cont)

TABLE 3. Stillbirths, ectopic pregnancies, miscarriages, and total reproductive losses

	Stillbirths N=25		Ectopic pregnancies N=50		Total reproductive losses N=385	
	AOR*	95% CI†	AOR	95% CI	AOR	95% CI
Deployment status						
Non deployed ‡						
Gulf War deployed	1.32	0.52, 3.34	0.92	0.49, 1.72	1.25	0.98, 1.59
Age group, in years						
<25‡						
25-29	1.10	0.41, 2.95	1.45	0.70, 2.99	1.05	0.80, 1.37
≥30	1.00	0.25, 3.96	2.09	0.88, 4.94	1.42	1.02, 1.99
Race/Ethnicity						
White ‡						
Black	1.02	0.29, 3.57	0.86	0.35, 2.15	0.82	0.57, 1.18
Hispanic, other	0.44	0.06, 3.32	0.18	0.02, 1.33	1.01	0.70, 1.46
Highest educational level						
High school or less ‡						
College or higher	0.62	0.24, 1.61	0.81	0.39, 1.67	1.15	0.86, 1.52
Service component						
Active duty ‡						
Reserve	§	§	§	§	0.78	0.30, 2.02

National Guard	§	§	2.89	0.36, 23.05	2.56	1.00, 6.55
Pre-1991 outcomes						
None	1.64	0.29, 9.26	0.97	0.33, 2.89	0.88	0.55, 1.38
Macrosomic births	2.46	0.41, 14.66	0.30	0.04, 2.48	0.59	0.31, 1.12
Normal weight births	0.93	0.18, 4.71	0.30	0.10, 0.88	0.56	0.36, 0.87
LBW births	2.80	0.30, 26.58	1.46	0.28, 7.54	1.37	0.66, 2.85
Stillbirths/ectopics	§	§	8.84	1.69, 46.30	2.62	0.94, 7.30
Miscarriages	1.86	0.36, 9.60	3.71	1.32, 10.49	1.55	0.98, 2.47

* AOR: Adjusted odds ratio; † CI: Confidence interval; ‡Reference category; § Insufficient data.

TABLE 3. Stillbirths, ectopic pregnancies, miscarriages, and total reproductive losses (cont)

TABLE 4. Miscarriages, by years post-Gulf War, military, and demographic covariates

	Miscarriages					
	1991-92 N=121		1993-95 N=189		1991-95 N=310	
	AOR*	95% CI†	AOR	95% CI	AOR	95% CI
Deployment status						
Nondeployed ‡						
Gulf War deployed	1.72	1.14, 2.59	1.21	0.88, 1.67	1.32	1.02, 1.73
Age group, in years						
≤19 ‡						
20-24	2.79	0.66, 11.76	0.95	0.46, 1.93	1.17	0.62, 2.23
25-29	2.39	0.56, 10.23	1.01	0.49, 2.08	1.17	0.61, 2.25
≥30	4.19	0.96, 18.36	1.14	0.52, 2.50	1.54	0.77, 3.07
Race/ethnicity						
White ‡						
Black	0.86	0.48, 1.52	0.74	0.45, 1.23	0.77	0.52, 1.15
Hispanic, other	1.35	0.70, 2.61	1.60	0.94, 2.74	1.44	0.91, 2.28
Highest educational level						
High school or less ‡						
College	1.44	0.89, 2.33	1.06	0.72, 1.54	1.25	0.91, 1.72
Postgraduate	1.02	0.41, 2.53	2.07	1.14, 3.75	1.81	1.07, 3.06

Service component						
Active duty ‡						
Reserve	1.28	0.38, 4.29	0.88	0.26, 2.91	0.92	0.35, 2.39
National Guard	0.71	0.09, 5.39	3.36	1.18, 9.53	2.44	0.92, 6.47
Pre-1991 outcomes						
None	0.84	0.41, 1.74	1.03	0.56, 1.92	0.88	0.54, 1.45
Macrosomic births	0.64	0.24, 1.75	0.75	0.32, 1.76	0.64	0.32, 1.28
Normal weight births	0.91	0.46, 1.80	0.52	0.28, 0.96	0.63	0.39, 1.01
LBW births	0.95	0.27, 3.38	1.64	0.65, 4.14	1.41	0.64, 3.07
Stillbirths/ectopics	1.69	0.36, 7.82	1.40	0.30, 6.50	1.73	0.54, 5.55
Miscarriages	1.35	0.68, 2.69	1.05	0.53, 2.08	1.18	0.70, 1.99

* AOR: Adjusted odds ratio; † CI: Confidence interval; ‡ Reference category.

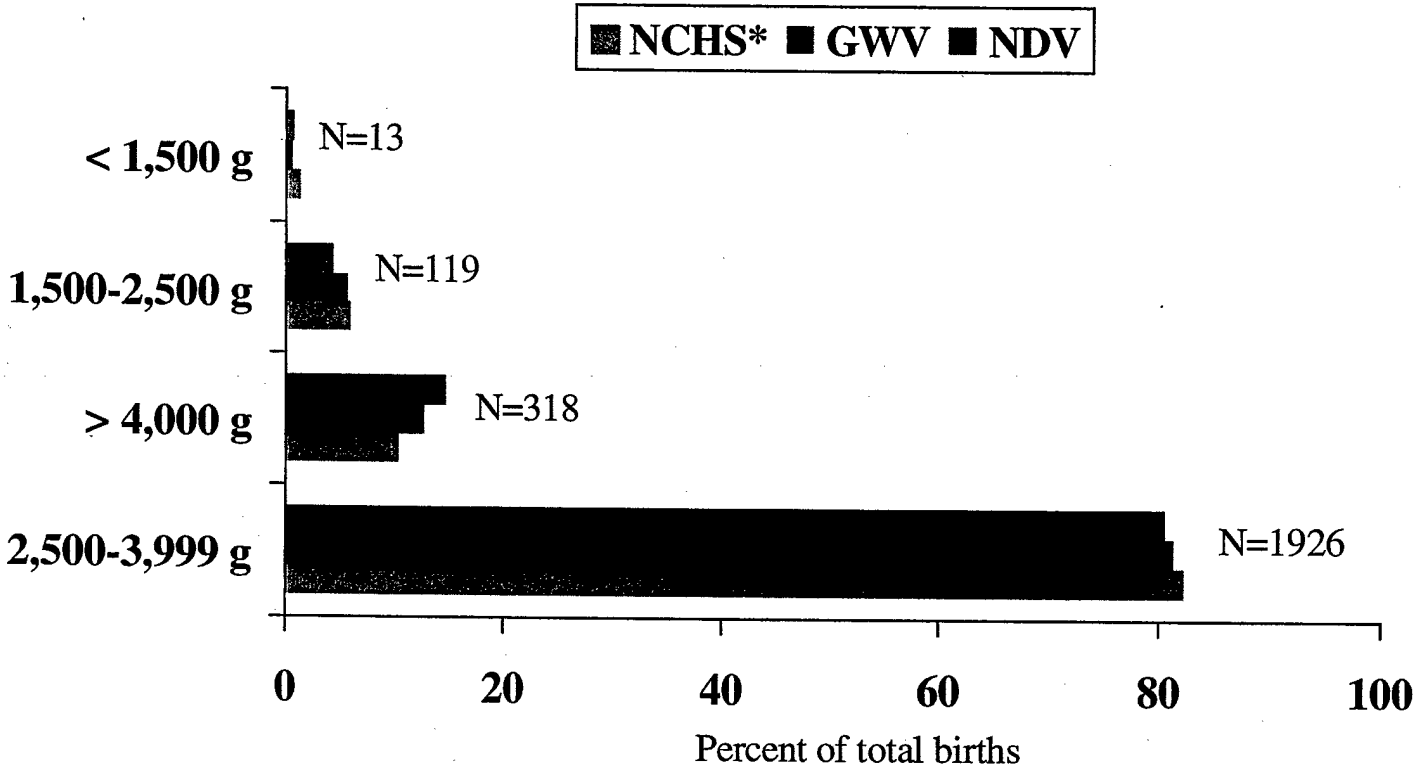
TABLE 4. Miscarriages, by years post-Gulf War, military, and demographic covariates (cont)

TABLE 5: Validation against hospitalization data of reproductive losses reported by female service members, by Gulf War deployment status

	Gulf War veterans			Nondeployed veterans		
	Reported *	Validated †	% Validated	Reported	Validated	% Validated
Miscarriages	295	46	15.6	173	31	17.9
Stillbirths	8	5	27.8	9	6	66.7
Ectopic pregnancies	34	9	24.5	28	7	25.0

* Reproductive losses reported in study survey by subjects.

† Discharge diagnosis ICD-9-CM code consistent with self-reported reproductive loss recorded in database for military medical treatment facility hospitalizations for year of self-reported outcome.


NCHS* GWV NDV
< 1,500 g
1,500-2,500 g
> 4,000 g
2,500-3,999 g
N=13
N=119
N=318
N=1926
0
20
40
60
80
100
Percent of total births

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14. ABSTRACT (maximum 200 words)

Veterans of the Persian Gulf War have complained of ill health, with diverse symptoms, since the war's end. We report here on postwar reproductive outcomes among spouses of male Gulf War veterans, compared with those among spouses of same-era male nondeployed veterans. From 1996, a probability-based sample of 8,915 deployed and nondeployed male military veterans aged 18-33 and married were mailed a reproductive health survey. A total of 2,716 Gulf War veterans and 2,169 nondeployed veterans returned the questionnaires, for a participation rate of 62.0 percent. Adjusting for age, race/ethnicity, educational attainment, military component, and pre-1991 reproductive outcomes, no statistically significant differences were found in the odds of reporting singleton or multiple births, ectopic pregnancies, or stillbirths. Male Gulf War veterans did report increased odds that their partners had experienced a miscarriage in the first 2 years following the Gulf War (adjusted OR= 1.72; 95 percent CI 1.14, 2.59).

15. SUBJECT TERMS
Gulf War, male veterans, reproductive outcomes.

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